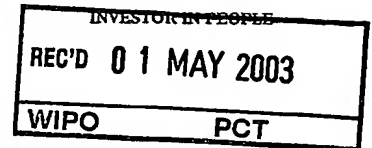




PCT/GB 2003 / 00 1 2 8 3
10/509907



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I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation and Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents held on the international application filed on 19 September 2002 under the Patent Cooperation Treaty at the UK Receiving Office. The application was allocated the number PCT/GB02/04296.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or the inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Date: 24 April 2003

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

| | |
|---|----------|
| For receiving Office use only | |
| PCT/GB 2002 / 004296 | |
| International Application No. | |
| 19 SEPTEMBER 2002 | 19.09.02 |
| International Filing Date | |
| United Kingdom Patent Office | |
| PCT International Application | |
| Name of receiving Office and "PCT International Application" | |
| Applicant's or agent's file reference (if desired) (12 characters maximum) GCL/8730 | |

| | |
|---|--|
| Box No. I TITLE OF INVENTION | |
| A mechanism including a piston-and-cylinder assembly | |
| Box No. II APPLICANT <input type="checkbox"/> This person is also inventor | |
| Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.) | |
| SHANE ENGINES LIMITED Plough Lane Bramshill, nr. Hook Hampshire RG27 0JX GB | |
| Telephone No. | |
| Facsimile No. | |
| Teleprinter No. | |
| Applicant's registration No. with the Office | |
| State (that is, country) of nationality: United Kingdom (GB) | |
| State (that is, country) of residence: United Kingdom (GB) | |
| This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box | |
| Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S) | |
| Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.) | |
| HUMPHRIES, Robin Hatchgate Farm Plough Lane Bramshill, nr. Hook Hampshire, RG27 0JX GB | |
| This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.) | |
| Applicant's registration No. with the Office | |
| State (that is, country) of nationality: United Kingdom (GB) | |
| State (that is, country) of residence: United Kingdom (GB) | |
| This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box | |
| <input type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet. | |
| Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE | |
| The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: <input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative | |
| Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) | |
| LEILA, George Conrad Abel & Imray 20 Red Lion Street London WC1R 4PQ England (GB) | |
| Telephone No. +44 (0) 20 7242 9984 | |
| Facsimile No. +44 (0) 20 7242 9989 | |
| Teleprinter No. | |
| Agent's registration No. with the Office | |
| <input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent. | |

Sheet No. ...2...

Box No. V DESIGNATION OF STATES

Mark the applicable check-boxes below; at least one must be marked.

The following designations are hereby made under Rule 4.9(a):

Regional Patent

- ☒ **AP ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, MZ Mozambique, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZM Zambia, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT (if other kind of protection or treatment desired, specify on dotted line)
- ☒ **EA Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP European Patent:** AT Austria, BE Belgium, CH & LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, TR Turkey, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GQ Equatorial Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | | |
|---|--|---|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> AG Antigua and Barbuda | <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> OM Oman |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> PH Philippines |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> IN India | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> IS Iceland | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> JP Japan | |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> BR Brazil | <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> KR Republic of Korea | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> BZ Belize | <input checked="" type="checkbox"/> KZ Kazakhstan | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> LC Saint Lucia | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> CH & LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> LK Sri Lanka | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> LR Liberia | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> CO Colombia | <input checked="" type="checkbox"/> LS Lesotho | <input checked="" type="checkbox"/> TN Tunisia |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> LT Lithuania | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> LU Luxembourg | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> LV Latvia | |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> MA Morocco | <input checked="" type="checkbox"/> TZ United Republic of Tanzania |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> MD Republic of Moldova | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> MG Madagascar | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> DZ Algeria | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> EC Ecuador | <input checked="" type="checkbox"/> MN Mongolia | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> MW Malawi | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> MX Mexico | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> MZ Mozambique | <input checked="" type="checkbox"/> ZA South Africa |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> NO Norway | <input checked="" type="checkbox"/> ZM Zambia |
| <input checked="" type="checkbox"/> GD Grenada | | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> GE Georgia | | |
| <input checked="" type="checkbox"/> GH Ghana | | |

Check-boxes below reserved for designating States which have become party to the PCT after issuance of this sheet:

☒ **VC Saint Vincent + the Grenadines**

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

Supplemental Box*If the Supplemental Box is not used, this sheet should not be included in the request.*

1. *If, in any of the Boxes, except Boxes Nos. VIII(i) to (v) for which a special continuation box is provided, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*

- (i) *if more than two persons are to be indicated as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*

- (ii) *if, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*

- (iii) *if, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*

- (iv) *if, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*

- (v) *if, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent of addition," or "certificate of addition," or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;*

- (vi) *if, in Box No. VI, there are more than five earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI.*

2. *If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.*

Continuation of Box IV - Additional Representatives

| | |
|------------|---------------------|
| COULSON | Antony John |
| BARRY, | Patrick James |
| SENIOR, | Janet |
| BARDO, | Julian Eason |
| MAIR, | Richard Douglas |
| HUMPHREYS, | Ceris |
| LEGG, | Cyrus James Grahame |
| PEARSON, | James Ginn |
| DENNESS, | James Edward |
| CRITTEN, | Matthew Peter |
| NETTLETON, | Victor |
| WHITING, | Gary |
| BRADY, | Paul Andrew |
| STARK, | Amanda Jane |

and also

| | |
|------------|----------------|
| DARBY, | David Thomas |
| SILVESTON, | Judith |
| SCOTT, | Susan Margaret |

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Sheet No. ... A ...

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

| Filing date of earlier application (day/month/year) | Number of earlier application | Where earlier application is: | | |
|---|----------------------------------|----------------------------------|---|--|
| | | national application: country | regional application:* regional Office | international application: receiving Office |
| item (1) 28/03/02 A 28 MARCH 2002 | 0207390.6 | GB | | |
| item (2) 12/07/02 A 12 JULY 2002 | 0216258.4 | GB | | |
| item (3) | | | | |
| item (4) | | | | |
| item (5) | | | | |

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office) identified above as:

☐ all items ☒ item (1) ☒ item (2) ☐ item (3) ☐ item (4) ☐ item (5) ☐ other, see Supplemental Box

* Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):

.....

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA / EPO

Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):

Date (day/month/year)

Number

Country (or regional Office)

Box No. VIII DECLARATIONS

The following declarations are contained in Boxes Nos. VIII (i) to (v) (mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):

Number of
declarations

- | | | |
|---|--|---|
| <input type="checkbox"/> Box No. VIII (i) | Declaration as to the identity of the inventor | : |
| <input type="checkbox"/> Box No. VIII (ii) | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent | : |
| <input type="checkbox"/> Box No. VIII (iii) | Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application | : |
| <input type="checkbox"/> Box No. VIII (iv) | Declaration of inventorship (only for the purposes of the designation of the United States of America) | : |
| <input type="checkbox"/> Box No. VIII (v) | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty | : |

Sheet No. ...5...

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) the following number of sheets in paper form:

request (including declaration sheets) : 5
 description (excluding sequence listing part) : 22
 claims : 9
 abstract : 1
 drawings : 9

Sub-total number of sheets : 46

sequence listing part of description (actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below) : _____

Total number of sheets : 46

(b) sequence listing part of description filed in computer readable form

(i) ☐ only (under Section 801(a)(i))(ii) ☐ in addition to being filed in paper form (under Section 801(a)(ii))

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained (additional copies to be indicated under item 9(ii), in right column): _____

This international application is accompanied by the following item(s) (mark the applicable check-boxes below and indicate in right column the number of each item):

1. ☐ fee calculation sheet :
 2. ☐ original separate power of attorney :
 3. ☐ original general power of attorney :
 4. ☐ copy of general power of attorney; reference number, if any: :
 5. ☐ statement explaining lack of signature :
 6. ☐ priority document(s) identified in Box No. VI as item(s): :
 7. ☐ translation of international application into (language): :
 8. ☐ separate indications concerning deposited microorganism or other biological material :
 9. ☐ sequence listing in computer readable form (indicate also type and number of carriers (diskette, CD-ROM, CD-R or other)) :
 (i) ☐ copy submitted for the purposes of international search under Rule 13ter only (and not as part of the international application) :
 (ii) ☐ (only where check-box (b)(i) or (b)(ii) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Rule 13ter :
 (iii) ☐ together with relevant statement as to the identity of the copy or copies with the sequence listing part mentioned in left column :
 10. ☐ other (specify): :

Number of items

Figure of the drawings which should accompany the abstract: Fig. 1

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).



George Conrad LEILA

For receiving Office use only

1. Date of actual receipt of the purported international application:

19 SEPTEMBER 2002 19.09.02.

3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:

4. Date of timely receipt of the required corrections under PCT Article 11(2):

5. International Searching Authority (if two or more are competent): ISA /

6. ☐ Transmittal of search copy delayed until search fee is paid

2. Drawings:

☒ received:☐ not received:

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

A mechanism including a piston-and-cylinder assembly

The invention relates to a mechanism including a piston-and-cylinder assembly.

5 The invention provides a mechanism including:
a piston-and-cylinder assembly including a piston housed in a cylinder,

a pin member passing through the piston and
a guide member having a guide slot accommodating an
10 end of the pin member,

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

15 the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other about the common axis and

the guide slot being so shaped as to guide the pin member in a continuous curve, causing the piston to sweep
20 up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

One form of the mechanism includes axial slots in the cylinder, the pin member engaging the axial slots, to serve as guide means to the piston.

25 Preferably, the axial slots lie on a diameter of the cylinder.

An alternative form of the mechanism includes guide means for the piston so positioned as to engage the piston shank.

~~30 Preferably, when guide means engage the piston shank,~~
the piston shank includes a rectangular portion and the guide means is of complementary shape and engages the rectangular portion of the piston shank.

Preferably, when guide means engage the piston shank, the piston shank includes an H-form transverse cross-section portion.

The invention also provides a mechanism including:
5 a piston-and-cylinder assembly including a first piston housed in a first cylinder and a second piston housed in a second cylinder,

a first pin member passing through the first piston and a second pin member passing through the second piston
10 and

a guide member having a guide slot accommodating an end of the first pin member and an end of the second pin member,

the guide slot being so shaped and orientated in
15 relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other
20 about the common axis and

the guide slot being so shaped as to guide the pin members in a continuous curve, causing the first and second pistons to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative
25 to each other.

Preferably, the form of the piston-and-cylinder assembly permits the first and second cylinders to lie diametrically opposed to each other.

Preferably, the mechanism includes:

~~30 at least one further pair of diametrically opposed~~
cylinders on the piston-and-cylinder assembly,
further pistons in the further cylinders and

further pin members passing through the pistons and being accommodated in the guide slot.

In one form of the mechanism, the guide slot is of a rhomboid shape with curved corners.

5 Preferably, the curved corners are parts of ellipses.

In another form of the mechanism, the guide slot is elliptical in shape.

In a further form of the mechanism, the guide slot includes three parts which are elliptical in shape and a
10 fourth part which is substantially straight, the straight part occupying a position corresponding to the expansion stroke of the piston or pistons.

In a yet further form of the mechanism, the guide slot has a dumbell shape including curved end portions separated
15 by a narrower waist portion.

Preferably, the dumbell-shaped guide slot provides linear motion of the piston, in relation to the angular rotation of the guide member, corresponding to the linear motion of the piston of a crankshaft-equipped engine in
20 relation to the angular rotation of the crankshaft, that is, at all piston displacements.

Preferably, in the yet further form of the mechanism, for corresponding linear motion of the pistons, the angular rotation of the guide member of the mechanism is a half of
25 the angular rotation of the crankshaft of a crankshaft-equipped engine, that is, at all piston displacements.

The yet further form of the mechanism, wherein, for corresponding linear motion of the pistons, the angular rotation of the guide member of the mechanism is a half of
30 the angular rotation of the crankshaft of a crankshaft-equipped engine includes:

a piston-and-cylinder assembly including a piston housed in a cylinder,

a pin member passing through the piston and
a guide member having a guide slot accommodating an
end of the pin member,

the guide slot being so shaped and orientated in
5 relation to the piston-and-cylinder assembly that a common
axis exists between the guide slot and the piston-and-
cylinder assembly,

the guide member and the piston-and-cylinder assembly
being so mounted as to be rotatable relative to each other
10 about the common axis and

the guide slot being so shaped that, for corresponding
linear motion of the pistons, the angular rotation of the
guide member is a half of the angular rotation of the
crankshaft of a crankshaft-equipped engine,

15 in the operation of the mechanism, the guide slot
guiding the pin member in a continuous curve, causing the
piston to so sweep up and down the cylinder, when the guide
member and the piston-and-cylinder assembly rotate relative
to each other.

20 The form of the guide slot is, of course, equally
applicable to a mechanism including a plurality of pistons
as it is to a mechanism including a single piston.

Preferably, the mechanism includes a second guide
member having a second guide slot accommodating the other
25 end of the pin member or the other ends of the pin members,
the second guide slot being so shaped and orientated in
relation to the piston-and-cylinder assembly as to share
the common axis existing between the first guide slot and
the piston-and-cylinder assembly

30 ~~In one arrangement, the mechanism includes axial slots~~
in the cylinders, the pin members engaging the axial slots
and, preferably, when axial slots are included, the axial
slots lie on diameters of the cylinders.

In an alternative arrangement, the mechanism includes guide means for the pistons so positioned as to engage the piston shanks.

5 Preferably, when guide means for the pistons are included, the piston shanks include a rectangular portion and the guide means is of complementary shape and engages the rectangular portion of the piston shank and, preferably, the piston shanks include an H-form transverse cross-section portion.

10 Preferably, the common axis is the axis of a shaft on which the guide member is rotatably mounted or the guide members are rotatably mounted, the piston-and-cylinder assembly being fixed.

15 As an alternative, the mechanism may be arranged as a rotary mechanism in which the common axis is the axis of a shaft on which the piston-and-cylinder assembly is rotatably mounted, the remainder of the mechanism being fixed. Such an alternative arrangement may be desirable in the event that a significant flywheel effect is required.

20 As a further alternative, the arrangement may be that the common axis is the axis of a shaft on which the guide member is or the guide members are rotatably mounted and the piston-and-cylinder assembly is rotatably mounted on the shaft.

25 Preferably, the mechanism includes bearing means at the end of the pin member or the ends of pin members accommodated in the guide slot, for effecting rolling contact between the peripheries of the guide slot and the end of the pin member or the ends of the pin members.

~~30~~ ~~Preferably, the bearing means at the end of the pin~~
member or the ends of the pin members includes an outer bearing assembly contacting only the outer periphery of a

guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

Preferably, the outer bearing assembly includes an outer cylindrical shell supported by a plurality of outer
5 rollers on the pin member, the outer cylindrical shell lying in contact with the outer periphery only of the guide slot.

Preferably, the inner bearing assembly includes an inner cylindrical shell supported by a plurality of inner
10 rollers on the pin member, the inner cylindrical shell lying in contact with the inner periphery only of the guide slot.

In a first arrangement, the outer and inner bearing assemblies are so mounted that the outer and inner
15 cylindrical shells rotate about the same axis.

In the first arrangement, the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the axis of the pin member.

In an alternative arrangement, the outer and inner
20 bearing assemblies are so mounted that the outer cylindrical shell rotates about an axis which is offset from the axis about which the inner cylindrical shell rotates.

In yet another arrangement, the bearing means includes
25 a ball bearing between the outer and inner bearing assemblies, the balls of the ball bearing running in tracks in the outer and inner cylindrical shells.

Preferably, the mechanism includes a guide slot having an inner periphery including a step in its profile for
30 ~~accommodating bearing means at the end of the pin member or~~
the ends of the pin members, the bearing means including an outer bearing assembly contacting only the outer periphery

of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

Preferably, the mechanism includes a guide slot having an outer periphery the surface of which is narrower than
5 the surface of the inner periphery, bearing means at the end of the pin member or the ends of the pin members including an outer bearing assembly contacting only the narrower surface of the outer periphery of a guide slot and an inner bearing assembly contacting only the surface of
10 the inner periphery of the guide slot.

An arrangement of the mechanism includes a guide slot having an inner periphery including a step in its profile and that arrangement includes:

a piston-and-cylinder assembly including a piston
15 housed in a cylinder,

a pin member passing through the piston and

a guide member having a guide slot, which has an inner periphery including a step in its profile, accommodating an end of the pin member,

20 the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

the guide member and the piston-and-cylinder assembly
25 being so mounted as to be rotatable relative to each other about the common axis and

the guide slot being so shaped as to guide the pin member in a continuous curve, causing the piston to sweep up and down the cylinder, when the guide member and the
~~30 piston-and-cylinder assembly rotate relative to each other.~~

In another arrangement of the mechanism, the guide slot has an outer periphery the surface of which is

narrower than the surface of the inner periphery,
providing:

a piston-and-cylinder assembly including a piston
housed in a cylinder,

5 a pin member passing through the piston and

a guide member having a guide slot, having an outer
periphery the surface of which is narrower than the surface
of the inner periphery, accommodating an end of the pin
member,

10 the guide slot being so shaped and orientated in
relation to the piston-and-cylinder assembly that a common
axis exists between the guide slot and the piston-and-
cylinder assembly,

the guide member and the piston-and-cylinder assembly
15 being so mounted as to be rotatable relative to each other
about the common axis and

the guide slot being so shaped as to guide the pin
member in a continuous curve, causing the piston to sweep
up and down the cylinder, when the guide member and the
20 piston-and-cylinder assembly rotate relative to each other.

One form of guide member includes a guide slot having
an inner periphery including a step in its profile and an
outer periphery the surface of which is narrower than the
surface of the inner periphery.

25 Yet another arrangement of the mechanism includes an
outer roller and an inner roller on the end of the pin
member, the outer roller contacting only the outer
periphery of the guide slot and the inner roller contacting
only the inner periphery of the guide slot, providing:

~~30 a piston and cylinder assembly including a piston
housed in a cylinder,~~

a pin member passing through the piston,

an outer roller and an inner roller on an end of the pin member and

a guide member having a guide slot accommodating the end of the pin member, the outer roller of the pin member
 5 contacting only the outer periphery of the guide slot and the inner roller contacting only the inner periphery of the guide slot,

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common
 10 axis exists between the guide slot and the piston-and-cylinder assembly,

the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other about the common axis and

15 the guide slot being so shaped as to guide the pin member in a continuous curve, causing the piston to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

A guide member including a guide slot having an inner
 20 periphery that includes a step in its profile is equally applicable to an arrangement of the mechanism including a plurality of pistons as it is to the arrangement including a single piston.

A guide member including a guide slot having an inner
 25 periphery including a step in its profile and an outer periphery the surface of which is narrower than the surface of the inner periphery is equally applicable to an arrangement of the mechanism including a plurality of pistons as it is to the arrangement including a single
 30 piston.

An arrangement of the mechanism including an outer roller and an inner roller on an end of the pin member and a guide member having a guide slot accommodating the end of

the pin member, wherein the outer roller of the pin member contacts only the outer periphery of the guide slot and the inner roller contacts only the inner periphery of the guide slot, is as applicable to an arrangement including a plurality of pistons as it is to the arrangement including a single piston.

Preferably, a plurality of apertures are included in the pin member or pin members for receiving and distributing lubricant to the end of the pin member or pin members.

Preferably, the mechanism includes a guide member having at least one aperture so positioned as to permit the delivery of lubricant through the guide member to the pin member or pin members.

Advantageously, the pistons and cylinders are pistons and cylinders of the heat engine and, in operation, generate motive power for the mechanism.

Preferably, the heat engine is an internal combustion engine.

The engine may be a Diesel-cycle engine or, alternatively, an Otto-cycle engine.

The engine may be four-stroke engine or, alternatively, a two-stroke engine.

A mechanism in accordance with the invention will now be described by way of example only with reference to the accompanying drawings in which:

Fig. 1 represents a front view of a first form of the mechanism showing a first form of guide slot included in a guide member accommodating six pin members and a piston-
~~and cylinder assembly having six cylinders mounted on a~~
shaft,

Fig. 2 represents a perspective view of the guide member of Fig. 1,

Fig. 3 represents a front view of the guide member of Fig. 1,

Fig. 4 represents a cross-section of the guide member of Fig. 3 taken along the line AA,

5 Fig. 5 represents a cross-section of the guide member of Fig. 3 taken along the line BB,

Fig. 6 represents a perspective outline view of the guide member of Fig. 3,

10 Fig. 7 represents a cross-section through the axis of a pin member and a guide member showing roller bearings between the pin member and the guide member,

Fig. 8 represents an end view of the pin member supported by a plurality of rollers belonging to the roller bearings of Fig. 7,

15 Fig. 9 is a view from below of a piston for the piston-and-cylinder assembly,

Fig. 10 is a perspective view of a partly assembled mechanism, showing the cylinder head, pistons and the guide member.

20 Fig. 11 represents a front view of a second form of the mechanism showing a guide slot of a second form included in a guide member accommodating six pin members and a piston-and-cylinder assembly having six cylinders mounted on a shaft,

25 Fig. 12 represents a front view of a guide slot of a third form included in a guide member accommodating four pin members,

Fig. 13 represents a front view of a piston-and-cylinder assembly showing details of a cylinder of a four-cylinder arrangement and

30 Fig. 14 represents a side view of the piston-and-cylinder assembly of Fig. 13.

Referring to Fig. 1 of the accompanying drawings, the mechanism includes a piston-and-cylinder assembly including a cylindrical carrier member 1 providing six cylinders 2 to 7 housing six pistons 8 to 13. Six pin members 14 to 19 pass diametrically through the pistons 8 to 13 and one set of the ends of the pin members 14 to 19 are accommodated in a guide slot having peripheries 20, 21 and 21a in a guide member 24. The piston-and-cylinder assembly and the guide slot have a common axis 22. The piston-and-cylinder assembly is mounted on a shaft 23 the axis of which is the common axis 22. The guide member 24 is attached to the shaft 23 and is rotatable about the common axis 22.

The peripheries 20, 21 and 21a of the guide slot and the pin members 14 to 19 are shown dotted to indicate that they are not visible in the drawing as viewed. The ends of the pin members 14 to 19 are provided with outer and inner roller bearings. As viewed in the drawing, an outer roller bearing lies directly over an inner roller bearing. The outer roller bearings lie in contact with the periphery 20 of the guide member 24 and do not contact the periphery 21 of the guide member 24. The inner roller bearings lie in contact with the periphery 21 and do not contact the periphery 20 of the guide member 24. The arrangement whereby the roller bearings contact only one of the two peripheries 20 and 21 of the guide member 24 is explained below with reference to Fig. 7 of the accompanying drawings.

Although not shown in Fig. 1, the mechanism includes another guide member providing another guide slot for ~~accommodating the other set of the ends of the pin members~~ 14 to 19, the guide slots being of the same shape.

The six cylinders 2 to 7 are evenly spaced around the cylindrical carrier member 1, their axes being 60 degrees

apart. The cylindrical carrier member 1 is, in practice, a cylindrical cylinder block.

In the operation of the mechanism shown in Fig. 1, the guide member rotates about the common axis 22 and the pin members 14 to 19 move along the guide slot, the pistons 8 to 13 sweeping up and down the cylinders 2 to 7 as the pin members 14 to 19 move along the guide slot.

The mechanism shown in Fig. 1 forms a part of a heat engine in which the pistons and cylinders are pistons and cylinders of the heat engine and, in operation, generate motive power for the mechanism. The details of the heat engine are not shown in Fig. 1

In the operation of the heat engine, mechanical energy is generated in the cylinders 2 to 7 and the pistons 8 to 13 as cylinders and pistons of the heat engine, causing the pistons 8 to 13 to reciprocate in the cylinders 2 to 7. The mechanical energy of the reciprocating pistons is translated into rotary motion of the guide member as a result of the pin members 14 to 19 moving along the guide slot shown in Fig. 1 and the second guide slot which is not shown.

Poppet valves are included in the heads of the cylinders 2 to 7 and are controlled by overhead camshafts of suitable profile for the required lift and dwell for the heat engine. A valve lifting mechanism may be included in the event that it is deemed necessary. In the case of a Diesel-cycle heat engine, provision may be made for operating an injection pump on the cylinder head or electrically operated injectors may be provided. Specific details of engine valve and fuel supply arrangements are not included since those matters are considered to be within the ability of a skilled person

The operating gas, usually air, for the heat engine enters the heads of the cylinders 2 to 7 in the conventional manner by way of an inlet poppet valve or inlet poppet valves. The gas charges are compressed in the cylinders; fuel being added during an induction part of a stroke in the case of a petrol spark-ignition engine or during a compression part of a stroke in the case of a heavy-oil non-spark-ignition engine. Exhaust gases leave the heat engine by way of exhaust valves and an exhaust pipe. Engine lubrication is effected by a pressurised oil system and cooling is effected by a radiator. Specific details of engine lubrication arrangements are not included since the matter of adequate engine lubrication is considered to be within the ability of a skilled person.

Rotation of the output shaft is clockwise as viewed in Fig. 1. The arrangement is ideal as regards balance since the opposed-piston configuration provides good counter-balance. For good balance, a minimum of two cylinders is required.

Variation of the shapes of the guide slots may be used in order to vary the performance of a heat engine including the mechanism. Variation of the size of the piston-and-cylinder assembly provides for different power requirements.

There are four parts to the guide slot corresponding to the induction, compression, expansion and exhaust strokes of the operating cycle of a reciprocating heat engine and, consequently, there is ignition once per revolution of the guide member for a four-stroke cycle.

That contrasts with more conventional four-stroke
arrangements, employing a crankshaft, in which there is ignition once every two revolutions of the crankshaft; thus a heat engine including the mechanism produces twice as

many power strokes as a conventional four-stroke arrangement, leading improved power output at lower revolutions.

Referring to Figs. 2 and 6 of the accompanying drawings, perspective views of the guide member 24 show the outer periphery 20 of the guide slot and the surfaces making up the inner peripheries 21 and 21a of the guide slot of the guide member 24. Although not altogether evident in Figs. 2 and 6, the surface of the outer periphery 20 is only about half the combined depth of the surfaces of the inner peripheries 21 and 21a and the guide slot as defined by the periphery 21a is wider than as defined by the periphery 21. The effects of the different depths of the surfaces of the peripheries 20, 21 and 21a and the different widths of the guide slot cause the roller bearings at the ends of the pin members 14 to 19 to contact only one periphery as is disclosed above. Lubrication ports 301, 302, 303 and 304 are also shown in Figs. 2 and 6.

Referring to Fig. 3 of the accompanying drawings, the guide member 24 includes a guide slot which is symmetrical about the line AA and, also, about the line BB. The guide slot is dumbbell-shaped, including rounded end portions and narrowing between the rounded end portions. The peripheries 20 and 21 of the guide slot are visible.

The guide slot is so shaped as to provide linear motion of the piston, in relation to the angular rotation of the guide member, corresponding to the linear motion of the piston of a crankshaft-equipped engine in relation to the angular rotation of the crankshaft, that is, at all piston displacements.

The guide slot is so shaped that, for corresponding linear motion of the pistons, the angular rotation of the guide member of the mechanism is a half of the angular

rotation of the crankshaft of a crankshaft-equipped engine. Thus, the mechanism provides the same linear motion for its piston or pistons for one-degree angular increments, say, of its guide member as does a crankshaft-equipped engine
5 for two-degree increments of the crankshaft, the piston or pistons of the mechanism moving between top and bottom dead centre for ninety degrees rotation of its guide member.

Also visible in Fig. 3 are the lubrication ports 301 - 304 in the guide member 24. Lubricant injected through the
10 apertures 301- 304 enters a pin member and is delivered to the caged needle rollers on the pin member through axial apertures shown in Fig. 7.

Figs. 4 and 5 of the accompanying drawings show that the reduced depth of surface of the outer periphery 20 of
15 the guide slot compared with the total depth of the surfaces 21 and 21a making up the inner peripheries of the guide slot of the guide member 24.

Referring to Fig. 7 of the accompanying drawings, a pin member such as the pin member 14, say, of Fig. 1 has
20 bearing means including an outer bearing assembly and an inner bearing assembly. The outer bearing assembly includes an outer cylindrical shell 142 and a plurality of needle rollers 1421 supporting the outer cylindrical shell 142 on the pin member 14. The inner bearing assembly includes an
25 inner cylindrical shell 141 and a plurality of needle rollers 1411 supporting the inner cylindrical shell 141 on the pin member 14. The inner cylindrical shell 141 includes a peripheral protrusion and the outer cylindrical shell 142 includes a peripheral depression into which the peripheral
30 protrusion of the inner cylindrical shell 141 fits. The outer and inner bearing assemblies 142 and 141 are retained on the pin member 14 by a retaining clip 155 and the fact that the end diameter of the pin member is reduced in

relation to the body of the pin member 14. The retaining clip 155 may be omitted and the bottom of the guide slot relied on to prevent the bearing assemblies from coming off the pin member 14.

5 The surface of the outer periphery 20 of the guide slot in the guide member 24 is narrower than the total width of the surfaces of the inner peripheries 21 and 21a of the guide slot in the guide member 24, there being a step between the two surfaces of the inner peripheries 21 and 21a. The step between the surfaces of the inner peripheries 21 and 21a of the guide slot in the guide member 24 causes the outer cylindrical shell 142 to run clear of surface of the inner periphery 21a while in contact with the surface of the outer periphery 20 of the guide slot. The inner cylindrical shell 141 runs along the surface of the inner periphery 21 of the guide slot and runs clear of the surface of the outer periphery 20 which does not extend up to the inner cylindrical shell 141. The arrangement shown in Fig. 7 permits the pin member 14 to be guided along the guide slot in contact with the inner and outer peripheries of the guide slot, the inner and outer cylindrical shells rotating in opposite senses.

20 A ball bearing may be introduced at the interface between the inner and outer cylindrical shells 141 and 142 by providing tracks in the inner and outer cylindrical shells 141 and 142 where they interface and placing a plurality of balls in the tracks.

25 As shown in Fig. 7, the pin member 14 is a cylindrical tube and includes a first plurality of axial apertures 143 - 148, in the vicinity of the bearing means at the end of the pin member 14 giving access to the interior of the pin member 14. A second plurality of axial apertures 149 - 154 is provided at the opposite end of the pin member 14 giving

access to the interior of the pin member 14. The axial apertures serve to distribute lubricant to the bearing means at the ends of the pin member 14, the lubricant being injected into the interior of the pin member 14 through apertures in the guide member 24.

Referring to Fig. 8 of the accompanying drawings, an end view of the pin member 14 at the bearing means shows that there are sixteen rollers 1421 included in the outer bearing assembly.

Referring again to Fig. 7, as an alternative to the arrangement shown in which the outer and inner bearing assemblies 141, 1411, 142, 1421 are so mounted as to rotate about the axis of the pin member 14, the outer bearing assembly 142, 1421 may be so mounted in relation to the mounting of the inner bearing assembly 141, 1411 that the outer cylindrical shell 1421 rotates about an axis which is offset from the axis about which the inner cylindrical shell 141 rotates. An offset in the axes of rotation serves to hold the outer and inner bearing assemblies 141, 1411, 142, 1421 more positively in contact with the surfaces 310 and 32b.

Fig. 9 of the accompanying drawings represents a view of a piston, for example, the piston 8 shown in Fig. 1 seen from below. As is evident from Fig. 9, the piston includes a shank 80 in the form of an H in transverse cross-section and has an axial aperture. A radial aperture 81 is provided for a pin member 14, say.

In one arrangement, an end of the pin member protrudes through a close-fitting axial slot in the wall of the cylinder 2 of Fig. 1 and into the guide slot in the guide member 24. In the arrangement including the close-fitting axial slot, the close-fitting axial slot and pin member

serve as guide means for the piston, limiting the piston to substantially axial movement without twisting.

In an alternative arrangement, an end of the pin member protrudes through an aperture in the wall of the cylinder that does not restrict the radial movement of the pin member, into the guide slot of the guide member 24. In the alternative arrangement, guide means for the piston engage the piston shank, limiting the piston to substantially axial movement without wobbling or twisting. In the case of the piston shown in Fig. 9, the guide means for the piston is of complementary form to the H-section form of the piston shank.

Fig. 10 of the accompanying drawings shows a perspective view of a partly assembled arrangement, in accordance with the invention, in which are visible the cylindrical carrier member 1 in cylinders of which are housed pistons 8, 9, 10, 11 and 13, a cylinder head 101 being visible at the position occupied by the piston 12. Also visible is the guide member 24 including the lubrication ports 301, 302, 303 and 304.

Referring to Fig. 11 of the accompanying drawings, a mechanism including an alternative shape of guide slot to that of Fig. 1 includes six cylinders 2 to 7 spaced evenly around the cylindrical carrier member 1 as in Fig. 1. The peripheries 220 and 221 of the guide slot are of a rhomboid shape with curved corners resulting in a guide slot which is of rhomboid shape with curved corners. The curves corners of the guide slot are parts of ellipses and the guide slot is relatively straight between the curved corners.

Referring to Fig. 12 of the accompanying drawings, a mechanism including a further alternative shape of guide slot includes a guide member 30 having a guide slot with

peripheries 31, 32 accommodating four pin members 33 to 36. The guide member 30 has a common axis 37 with a corresponding piston-and-cylinder assembly which is not shown. The corresponding piston-and-cylinder assembly has
5 four pistons and cylinders spaced ninety degrees apart for ideal balance conditions. The operation of the mechanism of Fig. 12 is the same as the operation of the mechanism of Fig. 1 described above and the operation of a heat engine including the mechanism of Fig. 12 is the same as the
10 operation of a heat engine as described above with reference to Fig. 1, except that a four-cylinder heat engine is expected to generate less power than a six-cylinder engine.

The guide slot shown in Fig. 12 has a rhomboid form
15 with curved corners which are parts of ellipses. The guide slot has, in effect, four parts and those parts correspond to the four strokes of a four-stroke heat engine which provide the induction, compression, expansion and exhaust phases of operation.

20 There are alternative shapes for the guide slot. For example, the guide slot may be elliptical in shape or may include three parts which are elliptical and a fourth part which is substantially straight, the fourth part corresponding to the expansion phase of operation.

25 Referring to Fig. 13 of the accompanying drawings, a piston-and-cylinder assembly includes four cylinders spaced ninety degrees apart and one cylinder 40 includes an axial slot 42 through which a pin member 41 passes, the pin member 41 also passing through the piston which is not
30 ~~visible. The axial slot 42 lies on a diameter of the~~

cylinder 40 and facilitates the assembly of the mechanism by holding the piston, which is a two-diameter piston, in the cylinder in the absence of a guide slot for performing

that function. The slot 42 is longer than the stroke of the piston as set by the guide slot and, consequently, the slot 42 does not influence the piston stroke which is determined by the guide slot. The axial slot is not essential to the
5 operation of the mechanism but does improve the mechanism by acting as a piston guide limiting any tendency for the piston to wobble or twist.

Referring to Fig. 14 of the accompanying drawings, the pin member 41 of Fig. 13 protrudes both forward and
10 backwards for engagement with front and rear guide slots (not shown) as does a further pin member 51. Valve members 52 and 53 are also shown in Fig. 14.

The pistons of the arrangements described above may be stepped in diameter, having the smaller or smallest
15 diameter at the position at which the pin member is accommodated.

A basic mechanism in accordance with the invention requires one piston and one cylinder with a pin member in engagement with one guide slot and, as is indicated in
20 relation to Fig. 13, an axial slot in the cylinder is not essential to the operation of the mechanism although a slot in the cylinder facilitates assembly and limits wobble and twisting of the piston.

The basic mechanism is operable as a part of a heat
25 engine, but if driven, is operable as a pump.

The mechanism is suitable for inclusion in Diesel-cycle and Otto-cycle heat engines. Two-stroke as well as four-stroke forms of either type of heat engine may include a mechanism in accordance with the invention. In a four-
30 stroke form of heat engine including a mechanism in
accordance with the invention, one spark occurs during a revolution of the guide member while, in a two-stroke form

of heat engine including the mechanism, two sparks occur during a revolution of the guide member.

The mechanism is also suitable for inclusion in a steam engine.

5 Further, either the piston-and-cylinder assembly or the guide member providing the guide slot may be rotatable²²⁰ or both may be rotatable to provide counter-rotating output shafts.

10 As is made clear above, balanced arrangements based on evenly spaced opposed cylinders are preferred and rotation of the guide member or members is preferred, although there are instances in which rotation of the piston-and-cylinder assembly is useful.

15 The axial slots in the cylinders could lie on a chord of the cylinder instead of a diameter of the cylinder but the position on the diameter leads to better balance.

CLAIMS

1. A mechanism including:

5 a piston-and-cylinder assembly including a piston
housed in a cylinder,
a pin member passing through the piston and
a guide member having a guide slot accommodating an
end of the pin member,

10 the guide slot being so shaped and orientated in
relation to the piston-and-cylinder assembly that a common
axis exists between the guide slot and the piston-and-
cylinder assembly,

the guide member and the piston-and-cylinder assembly
15 being so mounted as to be rotatable relative to each other
about the common axis and

the guide slot being so shaped as to guide the pin
member in a continuous curve, causing the piston to sweep
up and down the cylinder, when the guide member and the
20 piston-and-cylinder assembly rotate relative to each other.

2. A mechanism as claimed in claim 1, including axial
slots in the cylinder, the pin member engaging the axial
slots, to serve as guide means to the piston.

25

3. A mechanism as claimed in claim 2, wherein the axial
slots lie on a diameter of the cylinder.

4. A mechanism as claimed in claim 1, including guide
30 means for the piston so positioned as to engage the piston
shank.

5. A mechanism as claimed in claim 4, wherein the piston shank includes a rectangular portion and the guide means is of complementary shape and engages the rectangular portion of the piston shank.

5

6. A mechanism as claimed in claim 5, wherein the piston shank includes an H-form transverse cross-section portion.

7. A mechanism including:

10

a piston-and-cylinder assembly including a first piston housed in a first cylinder and a second piston housed in a second cylinder,

15

a first pin member passing through the first piston and a second pin member passing through the second piston and

a guide member having a guide slot accommodating an end of the first pin member and an end of the second pin member,

20

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

25

the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other about the common axis and

30

the guide slot being so shaped as to guide the pin members in a continuous curve, causing the first and second pistons to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

8. A mechanism as claimed in claim 7, wherein the form of the piston-and-cylinder assembly permits the first and

second cylinders to lie diametrically opposed to each other.

9. A mechanism as claimed in claim 8, including at least
5 one further pair of diametrically opposed cylinders on the piston-and-cylinder assembly,

further pistons in the further cylinders and
further pin members passing through the pistons and
being accommodated in the guide slot.

10

10 A mechanism as claimed in any one of claims 1 to 9,
wherein the guide slot is of a rhomboid shape with curved
corners.

15 11. A mechanism as claimed in claim 10, wherein the curved
corners are parts of ellipses.

12. A mechanism as claimed in any one of claims 1 to 9,
wherein the guide slot is elliptical in shape.

20

13. A mechanism as claimed in any one of claims 1 to 9,
wherein the guide slot includes three parts which are
elliptical in shape and a fourth part which is
substantially straight, the straight part occupying a
25 position corresponding to the expansion stroke of the
piston or pistons.

14. A mechanism as claimed in any one of claims 1 to 9,
wherein the guide slot has a dumbbell shape including
30 curved end portions separated by a narrower waist portion.

15. A mechanism as claimed in any one of claims 1 to 9 or
claim 14, wherein the guide slot is so shaped as to provide

linear motion of the piston, in relation to the angular rotation of the guide member, corresponding to the linear motion of the piston of a crankshaft-equipped engine in relation to the angular rotation of the crankshaft.

5

16. A mechanism as claimed in claim 15, wherein, for the corresponding linear motion of the pistons, the angular rotation of the guide member of the mechanism is a half of the angular rotation of the crankshaft of a crankshaft-equipped engine.

10

17. A mechanism as claimed in any one of claims 1 to 16, including a second guide member having a second guide slot accommodating the other end of the pin member or the other ends of the pin members, the second guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly as to share the common axis existing between the first guide slot and the piston-and-cylinder assembly

15
20

18. A mechanism as claimed in any one of claims 7 to 9 and claims 10 to 17 when appended to any one of claims 7 to 9, including axial slots in the cylinders, the pin members engaging the axial slots.

25

19. A mechanism as claimed in claim 18, wherein the axial slots lie on diameters of the cylinders.

30

20. A mechanism as claimed in any one of claims 7 to 9 and claims 10 to 17 when appended to any one of claims 7 to 9, including guide means for the pistons so positioned as to engage the piston shanks.

21. A mechanism as claimed in claim 20, wherein the piston shanks include a rectangular portion and the guide means is of complementary shape and engages the rectangular portion of the piston shank.

5

22. A mechanism as claimed in claim 21, wherein the piston shanks include an H-form transverse cross-section portion.

10

23. A mechanism as claimed in any one of claims 1 to 22, wherein common axis is the axis of a shaft on which the piston-and-cylinder assembly is rotatably mounted, the remainder of the mechanism being fixed.

15

24. A mechanism as claimed in any one of claims 1 to 22, wherein the common axis is the axis of a shaft on which the guide member is rotatably mounted or the guide members are rotatably mounted, the piston-and-cylinder assembly being fixed.

20

25. A mechanism as claimed in any one of claims 1 to 22, wherein the common axis is the axis of a shaft on which the guide member is or the guide members are rotatably mounted and the piston-and-cylinder assembly is rotatably mounted on the shaft.

25

26. A mechanism as claimed in any one of claims 1 to 25, including bearing means at the end of the pin member or the ends of pin members accommodated in the guide slot, for effecting rolling contact between the peripheries of the guide slot and the end of the pin member or the ends of the

30

pin members.

27. A mechanism as claimed in claim 26, wherein the bearing means at the end of the pin member or the ends of the pin members includes an outer bearing assembly contacting only the outer periphery of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

28. A mechanism as claimed in claim 27, wherein the outer bearing assembly includes an outer cylindrical shell supported by a plurality of outer rollers on the pin member, the outer cylindrical shell lying in contact with the outer periphery only of the guide slot.

29. A mechanism as claimed in claim 27 or claim 28, wherein the inner bearing assembly includes an inner cylindrical shell supported by a plurality of inner rollers on the pin member, the inner cylindrical shell lying in contact with the inner periphery only of the guide slot.

30. A mechanism as claimed in claim 28 or claim 29, wherein the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the same axis.

31. A mechanism as claimed in any one of claims 28 to 30, wherein the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the axis of the pin member.

32. A mechanism as claimed in claim 28 or claim 29, wherein the outer and inner bearing assemblies are so mounted that the outer cylindrical shell rotates about an

axis which is offset from the axis about which the inner cylindrical shell rotates.

33. A mechanism as claimed in any one of claims 28 to 31, wherein the bearing means includes a ball bearing between the outer and inner bearing assemblies, the balls of the ball bearing running in tracks in the outer and inner cylindrical shells.

34. A mechanism as claimed in any one of claims 1 to 33, including a guide slot having an inner periphery including a step in its profile for accommodating bearing means at the end of the pin member or the ends of the pin members, the bearing means including an outer bearing assembly contacting only the outer periphery of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

35. A mechanism as claimed in any one of claims 1 to 34, including a guide slot having an outer periphery the surface of which is narrower than the surface of the inner periphery, bearing means at the end of the pin member or the ends of the pin members including an outer bearing assembly contacting only the narrower surface of the outer periphery of a guide slot and an inner bearing assembly contacting only the surface of the inner periphery of the guide slot.

36. A mechanism as claimed in any one of claims 1 to 36, ~~wherein a plurality of apertures are included in the pin member or pin members for receiving and distributing lubricant to the end of the pin member or pin members.~~

37. A mechanism as claimed in claim 37, including a guide member having at least one aperture so positioned as to permit the delivery of lubricant through the guide member to the pin member or pin members.

5

38. A mechanism as claimed in any one of claims 1 to 33, including a guide slot having an inner periphery including a step in its profile.

10

39. A mechanism as claimed in any one of claims 1 to 33, including a guide slot having an outer periphery the surface of which is narrower than the surface of the inner periphery.

15

40. A mechanism as claimed in any one of claims 1 to 33, including a guide slot having an inner periphery including a step in its profile and an outer periphery the surface of which is narrower than the surface of the inner periphery.

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41. A mechanism as claimed in any one of claims 1 to 25, including an outer roller and an inner roller, or outer rollers and inner rollers, on the end of the pin member or on the ends of the pin members, the outer roller or rollers contacting only the outer periphery of the guide slot and

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the inner roller or rollers contacting only the inner periphery of the guide slot.

42. A mechanism substantially as herein described with reference to and as shown in Figs. 1 to 8 and 10 or Fig 11 or Figs. 12 and 13, of the accompanying drawings.

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43. A heat engine including a mechanism as claimed in any one of claims 1 to 42, wherein the pistons and cylinders

are pistons and cylinders of the heat engine and, in operation, generate motive power for the mechanism.

5 44. A heat engine as claimed in claim 43, which is an internal combustion engine.

45. An engine as claimed in claim 43 or claim 44, which is a Diesel-cycle engine.

10 46. An engine as claimed in claim 43 or claim 44, which is an Otto-cycle engine.

47. An engine as claimed in claimed in any one of claims 43 to 46, which is a four-stroke engine.

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48. An engine as claimed in any one of claims 43 to 46, which is a two-stroke engine.

ABSTRACT

A mechanism including a piston-and-cylinder assembly

- 5 A mechanism including a piston-and-cylinder assembly including a pin member passing through the piston and a guide member having a slot accommodating the end of the pin member, the guide member being rotated by reciprocating movement of the pistons.

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Fig. 1

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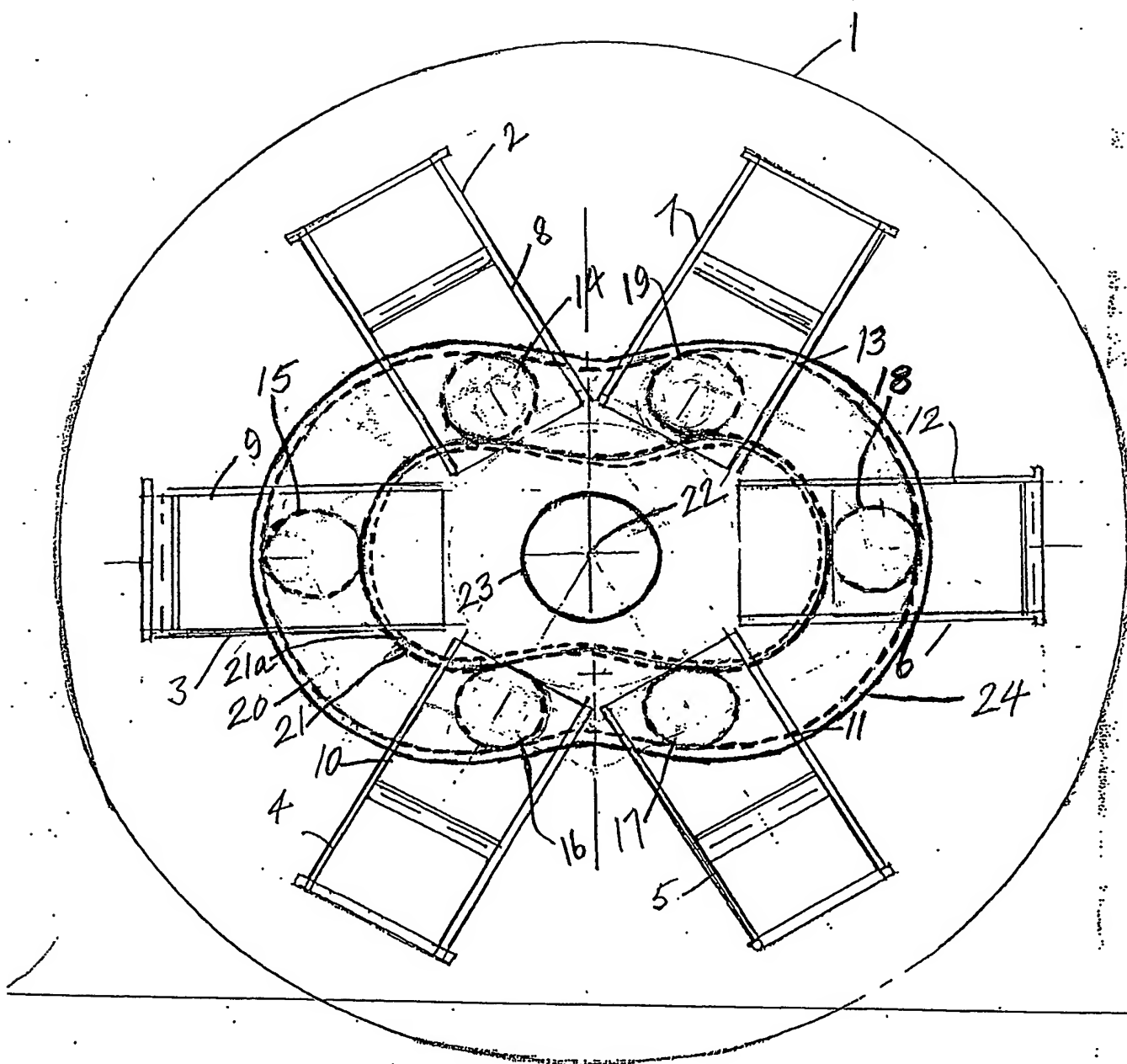
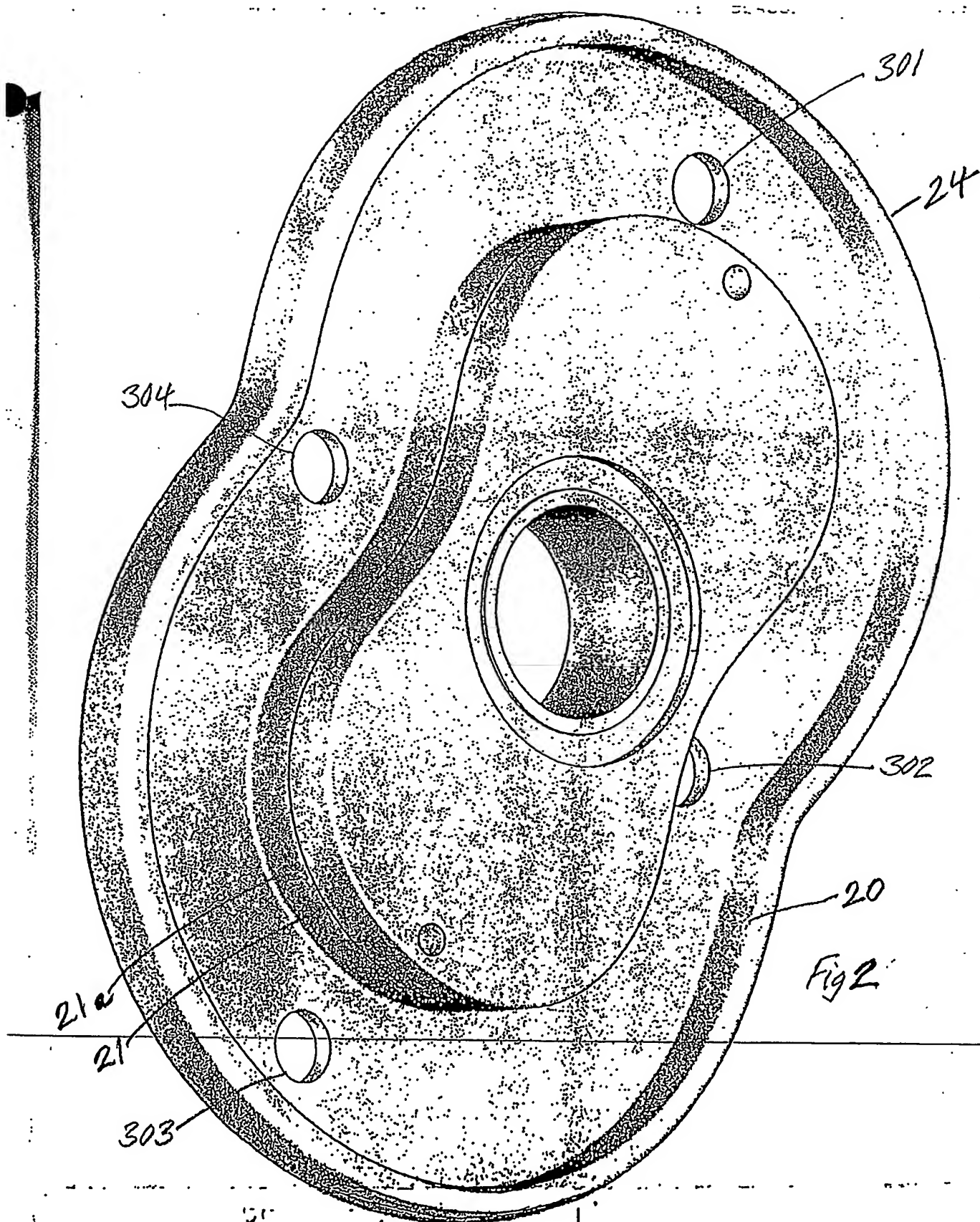
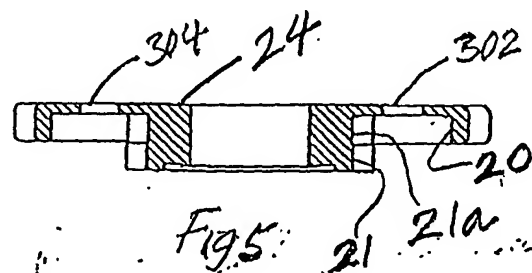
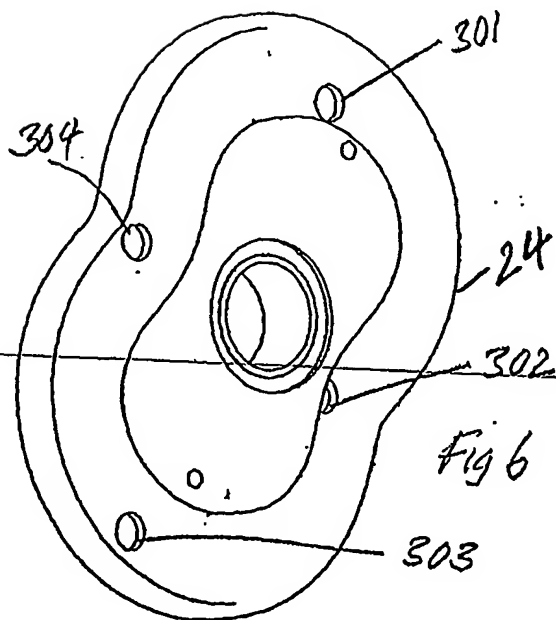
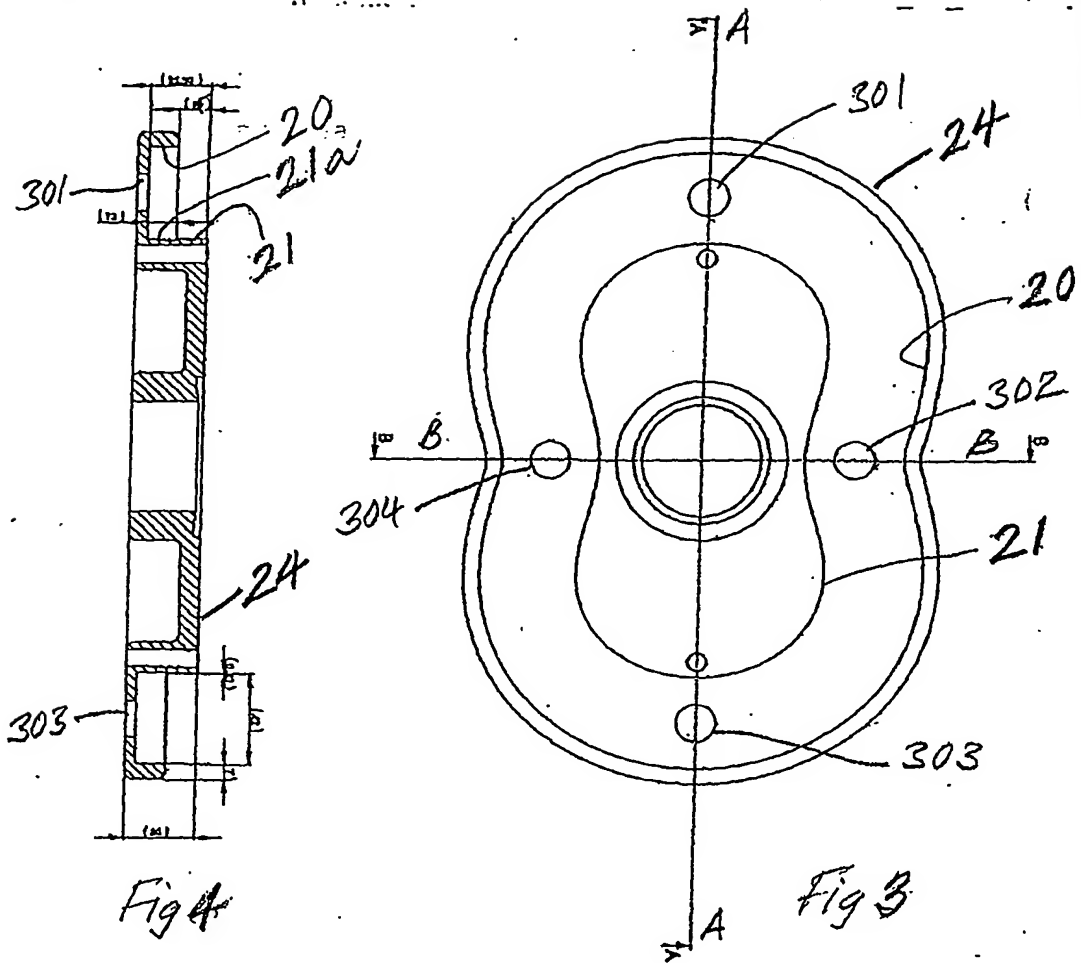


Fig 1

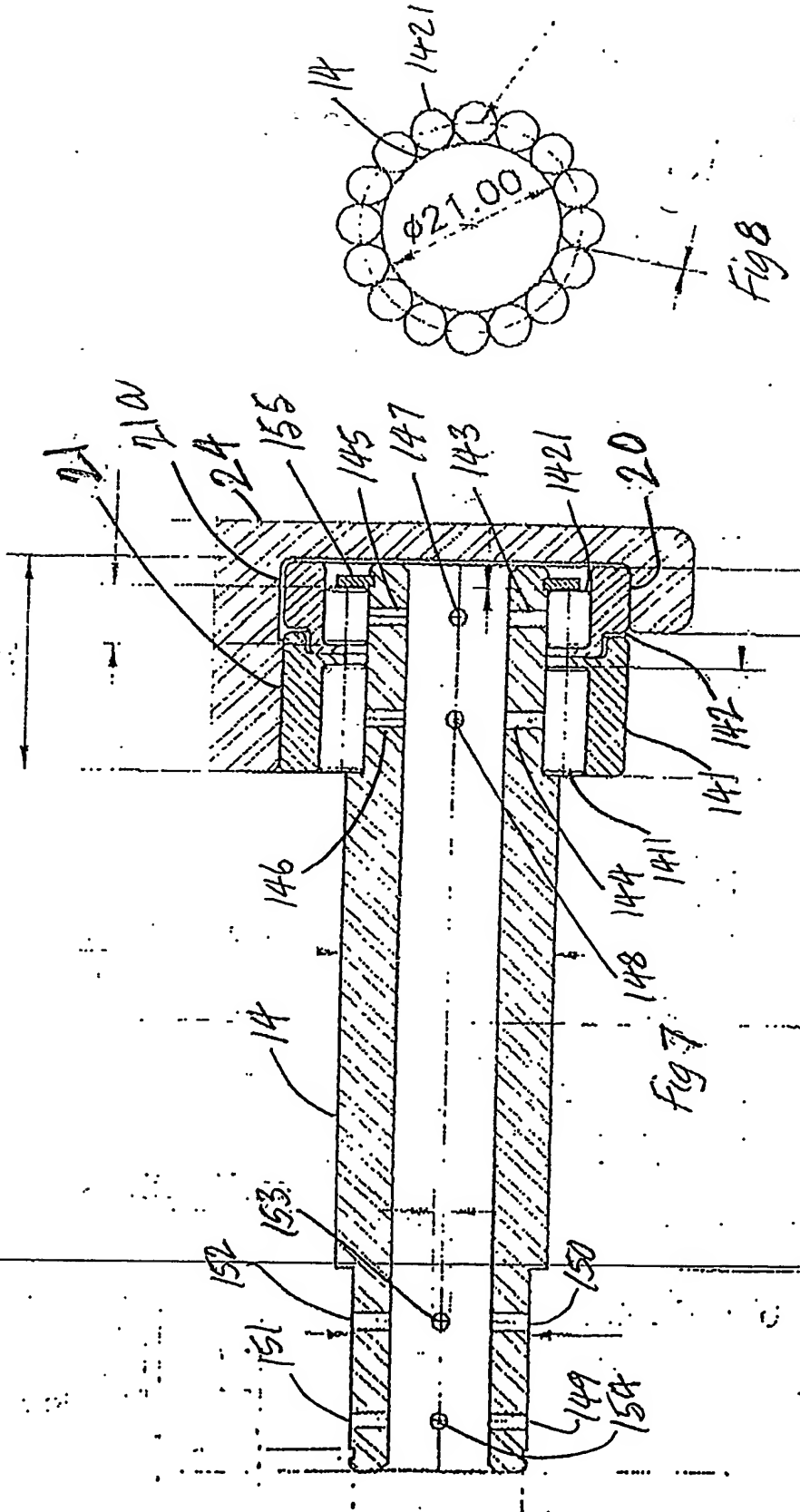
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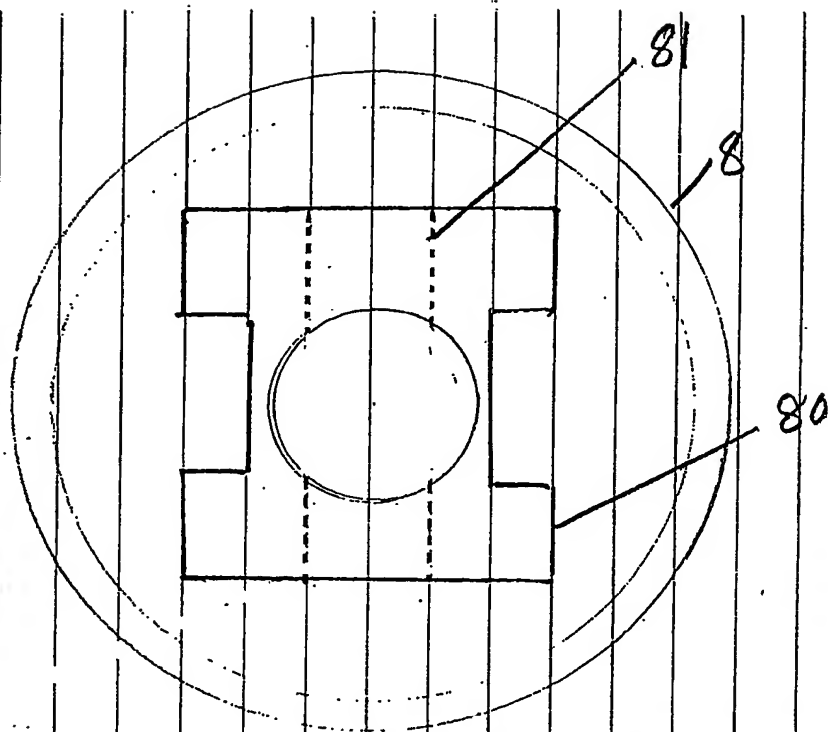


Fig 9

A perspective view of a mechanical assembly 1. The assembly features a main body with a large circular opening 13. A threaded cap 8 is positioned on top of the body. A flange 9 is located at the top left. A large circular component 101 is shown in the foreground. Various parts are labeled with numbers: 1, 8, 9, 101, 13, 24, 301, 302, 303, and 11.

Fig 10

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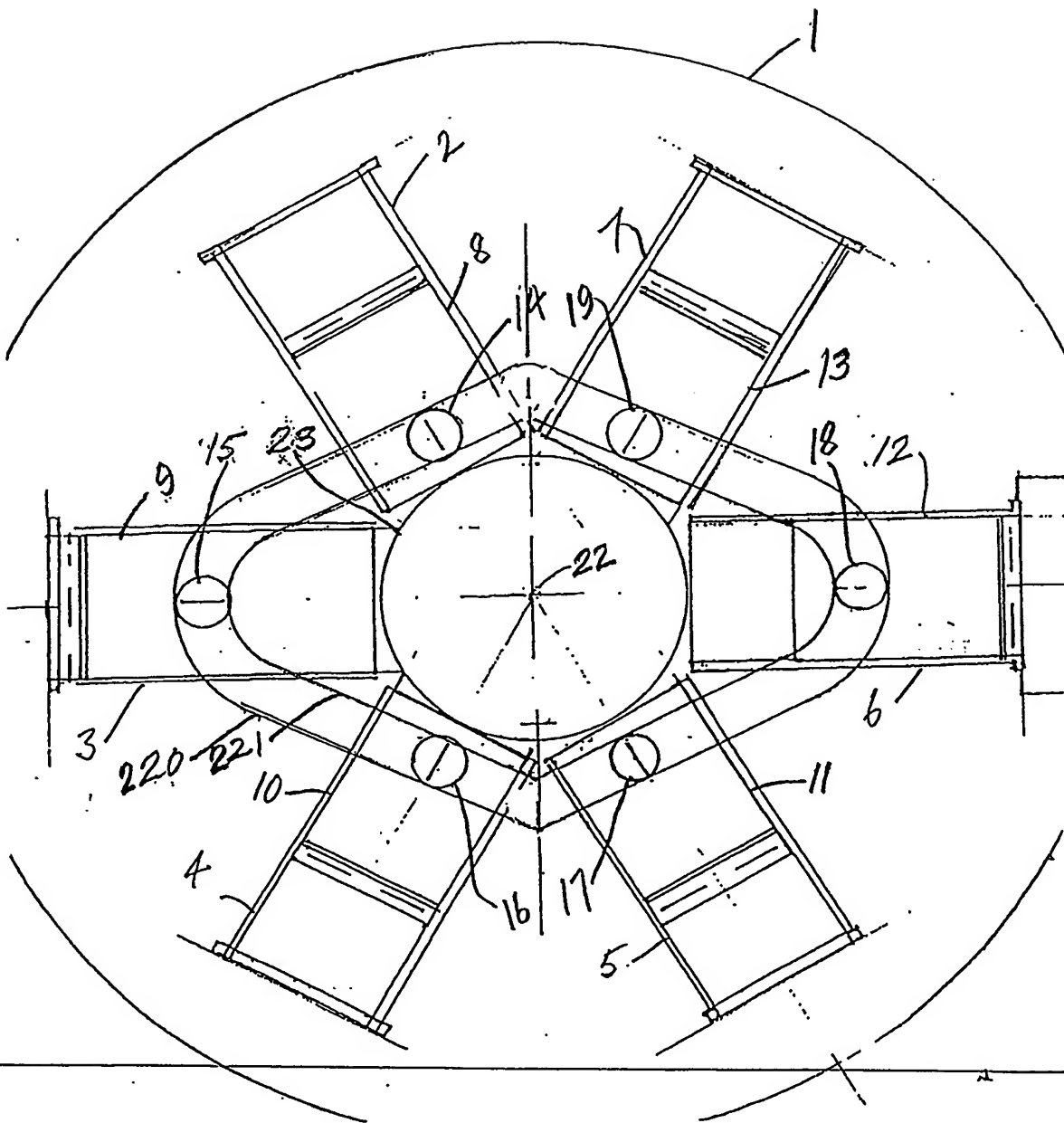


Fig 11

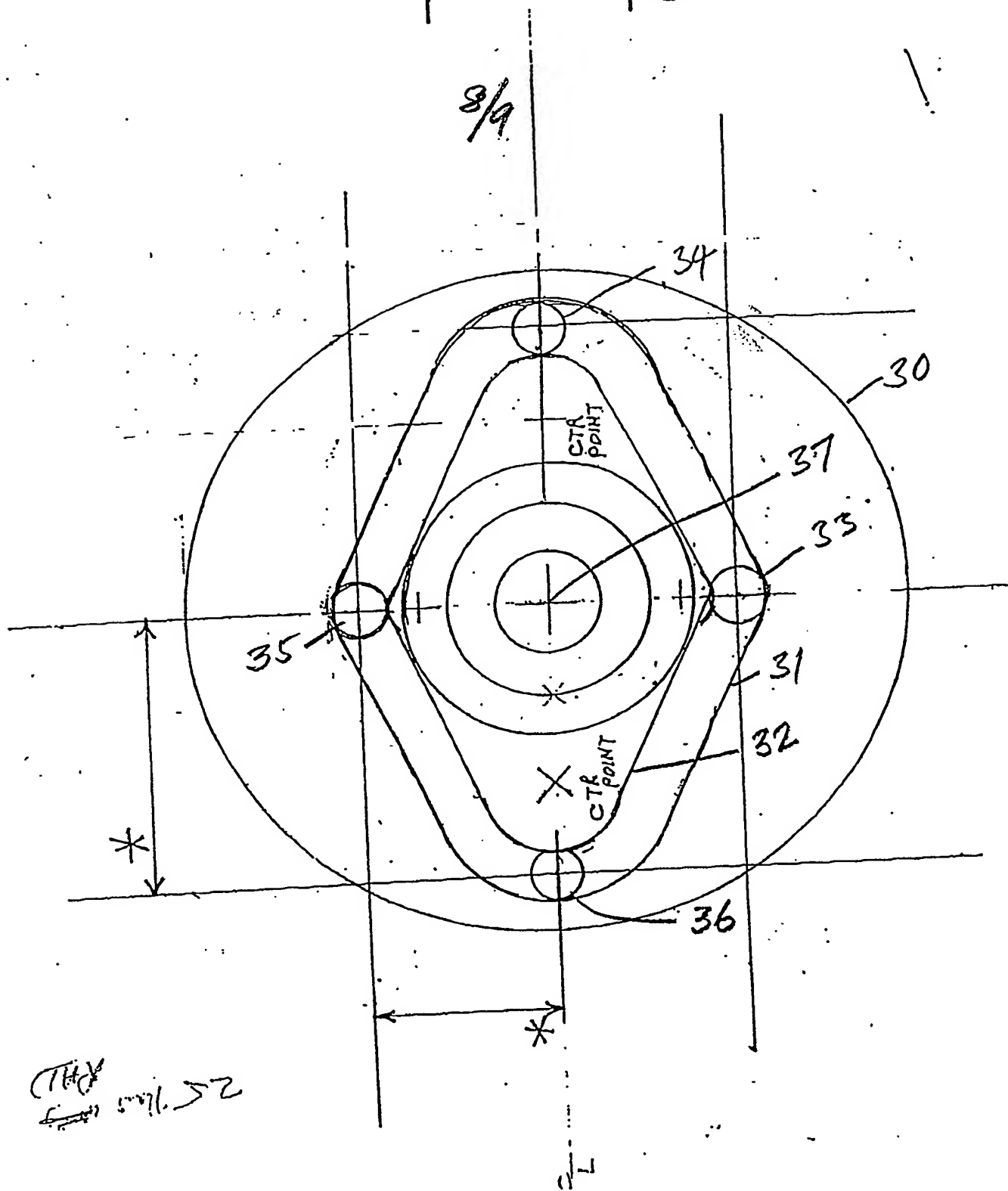


Fig 12

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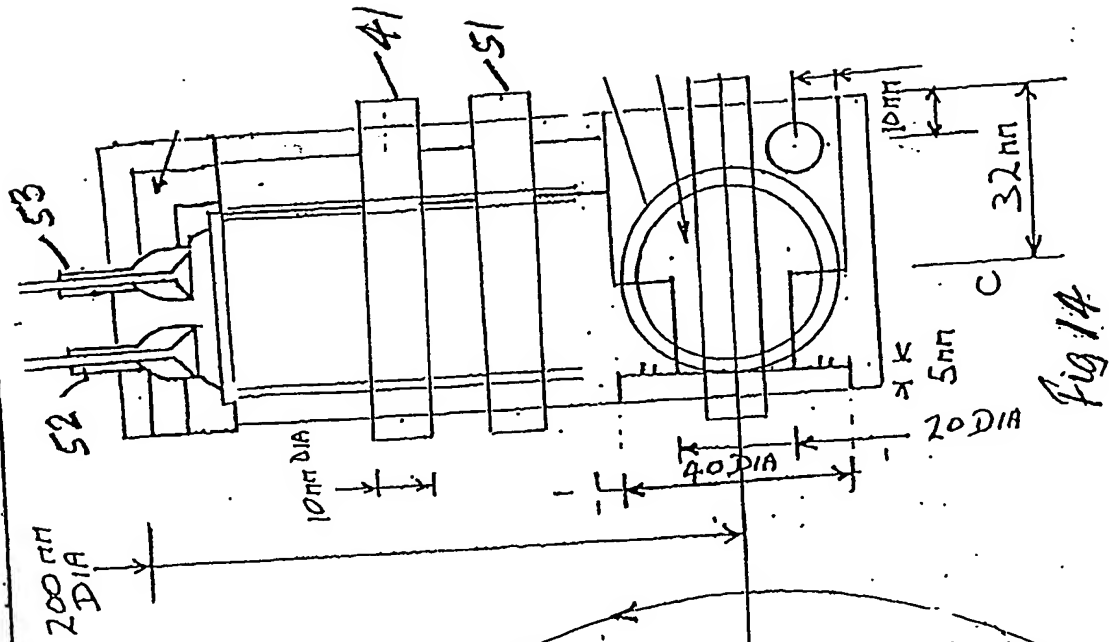


Fig 14

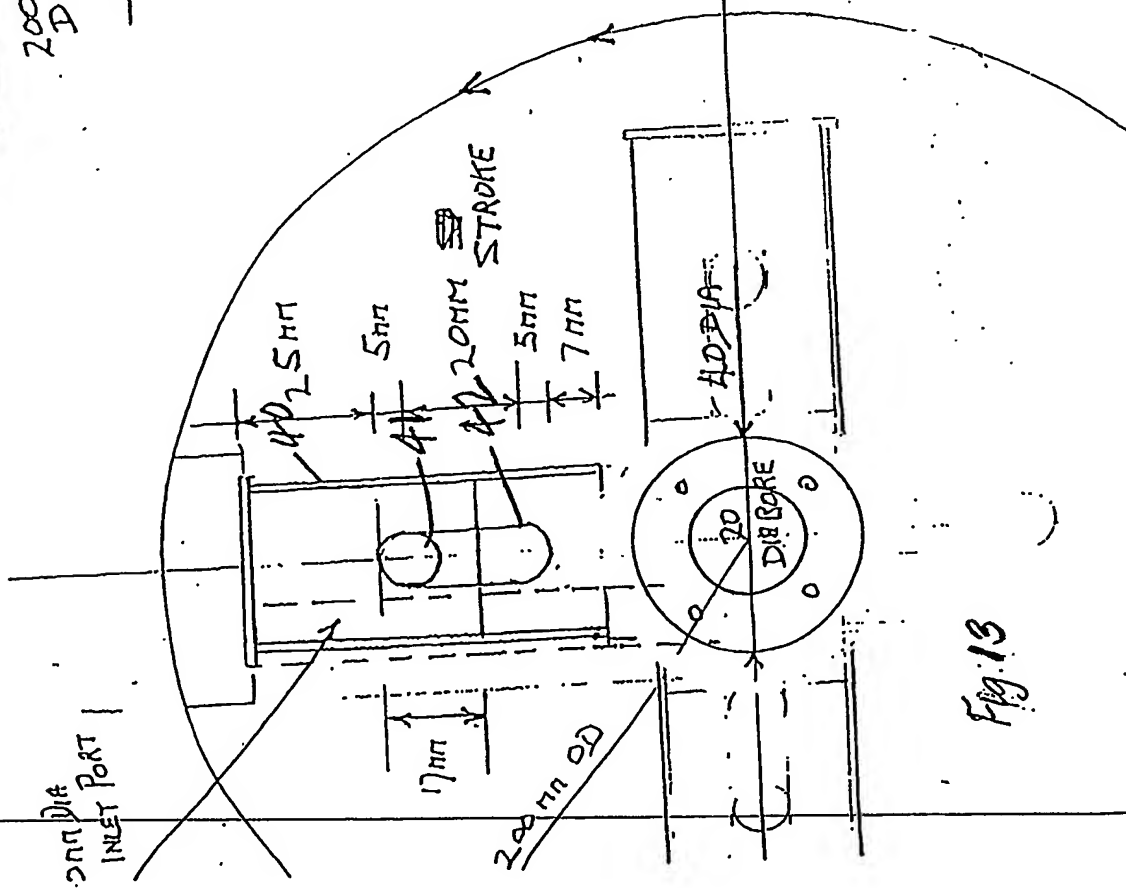


Fig 13

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